Scenario Planning for Connected and Automated Vehicles

Association of Metropolitan Planning Organizations
San Antonio, TX

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Process Step | Outputs for your Agency
---|---
1. Define and Understand CV/AV: | • Definitions and terminology surrounding CV and AV  
• Knowledge of interrelated technologies and emergent phenomenon
2. Determine goals and stakeholders in your planning process | • Identifying agency goals from scenario planning  
• Determining staff roles, task forces, and the scope of stakeholder outreach that is helpful and feasible for your agency’s planning process  
• Form a CV/AV scenario planning task force
3. Understand Driving Forces and Scenario Origins | • Ability to see how combinations of forces result in scenarios  
• Understanding of the scenario development process  
• Understanding of scenario ranking systems
4. Frame and Tailor the Scenarios | • Learn the fundamentals of the 6 CV/AV scenarios  
• Tailor the scenarios to your region, identifying how they manifest locally  
• Identify relevant regional stakeholders in each scenario
5. Incorporate Scenario Results into Decision-Making | • Identify local risks and opportunities  
• Create an action list and prioritize  
• Adjust plans, policies, operational strategies, and investments
6. Monitor industry and policy developments | • Monitor industry and policy developments related to CV and AV, and adjust plans where necessary
1. Define and Understand CV/AV:

- Definitions and terminology surrounding CV and AV
- Knowledge of interrelated technologies and emergent phenomenon
Connected Vehicles

- Cars, trucks, buses “talk” to each other using wireless and/or Dedicated Short Range Communications (DSRC) technology (V2V)
- Vehicles “talk” to roadway infrastructure traffic signals, toll booths, work zones, school zones, etc. (V2I)
- Vehicle systems alert drivers to real-time changes, threats, dangers, opportunities (V2X)

Source: CV Fact Sheet. USDOT Intelligent Transportation Systems Joint Program Office 2015.
## Autonomous Vehicles

### Society of Automotive Engineers (SAE) Automation Levels

<table>
<thead>
<tr>
<th>Level</th>
<th>Automation Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Automation</td>
<td>Zero autonomy; the driver performs all driving tasks.</td>
</tr>
<tr>
<td>1</td>
<td>Driver Assistance</td>
<td>Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.</td>
</tr>
<tr>
<td>2</td>
<td>Partial Automation</td>
<td>Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times.</td>
</tr>
<tr>
<td>3</td>
<td>Conditional Automation</td>
<td>Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice.</td>
</tr>
<tr>
<td>4</td>
<td>High Automation</td>
<td>The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.</td>
</tr>
<tr>
<td>5</td>
<td>Full Automation</td>
<td>The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.</td>
</tr>
</tbody>
</table>
Autonomous Vehicles

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) AUTOMATION LEVELS

0  No Automation

1  Driver Assistance

2  Partial Automation

3  Conditional Automation

4  High Automation

5  Full Automation

See Notes for photo credits
Mobility as a Service

- Journey planning
- Shared cars, bikes, scooters
- Cross platform payment
- Subscriptions
- Transportation Network Companies (TNCs)
  - San Francisco, 2016: 20% of intra-city VMT (SFCTA)
  - US, 2030: 95% of US passenger miles (ReThinkX)
- Platform for EV growth

www3.weforum.org/docs/WEF_Connected_World_HyperconnectedTravelAndTransportationInAction_2014.pdf
2. Determine goals and stakeholders in your planning process

- Identifying agency goals from scenario planning
- Determining staff roles, task forces, and the scope of stakeholder outreach that is helpful and feasible for your agency’s planning process
- Form a CV/AV scenario planning task force
Types of Scenario Planning

Normative: What SHOULD happen?

Set Goals

- How might we grow?
  - Consider possible futures

- How do we want to grow?
  - Envision a preferred future

- How could we achieve our vision?

Exploratory: What COULD happen?

Shape Tactics

- How might conditions change?
  - Consider possible trajectories

- How could change affect our plans?
  - Evaluate risks and opportunities

- How could we adjust?
What do you want to achieve?

- **What kinds of decisions will this support?**
  - Long range plan goals, strategies, considerations
  - Risk management
  - Technology strategic plan
  - Investments in emerging technology
  - Investments affected by emerging technology
  - Staff expertise and capacity

- **Who should be involved?**
  - Technology / data experts
  - Modeling staff
  - Partners – transit agencies, private providers, universities….
Assemble Information/ Resources

- Transit availability/ ridership
- Demographic data/ forecasts
- Commuter mode share
- VMT/ congestion trends
- Current technology status
- Existing/ planned policies
3. Understand Driving Forces and Scenario Origins

- Ability to see how combinations of forces result in scenarios
- Understanding of the scenario development process
- Understanding of scenario ranking systems
Scenario Building Blocks

Forces
- environment
- economy
- society
- technology

Levers
- Investments in infrastructure conditions
- travel choices
- equitable access

Outcomes
- congestion
- reliability
- safety
- quality of life
Forces and Levers

Technological Advances

Lifestyle/Consumer Preferences

Socio-Economic Factors

Policy/Regulations

- ... fuel sources.. energy systems ... climate conditions ... funding ...
Scenario Time Horizon

- Near enough to be relevant
- Far enough to be visionary
- Capture the trajectories
  - Tipping points
  - Trends

Tipping points include watershed events or “critical mass” evolutionary shifts that indicate a significant change in direction or magnitude.
Scenario Development Ground Rules

- DO NOT attempt to predict the future
- DO NOT try to pick winners
- DO envision several possible futures
- DO factor in revolutionary change, but also adaptation
4. Frame and Tailor the Scenarios

- Learn the fundamentals of the 6 CV/AV scenarios
- Tailor the scenarios to your region, identifying how they manifest locally
- Identify relevant regional stakeholders in each scenario
2035 CV/AV Scenarios

**Enhanced Driving Experience**
- Managed Automated Lanes
  AV lane networks
  AV travel is consolidated to a large-scale lane network with significant consumer adoption
- Ultimate Traveler Assist
  Ultra-Connectivity
  AV adoption stalls, CV becomes ubiquitous

**Baseline**
- Baseline
  Minimal Plausible Change
  Accounts for advances in safety technology, TSMO and mobility services

**Driver Becomes Mobility Consumer**
- Niche Service Growth
  High AV/CV in certain cases
  Niche applications for CV/AV dominate the landscape
- Competing Fleets
  Automated TNC fleets compete
  Level-4 AV is safe for most trips, travel is dominated by competing fleets
- Integrated Automated Mobility
  Automated mobility-as-a-service
  High automation, strong public-private partnership for system optimization

**Trajectories towards CV/AV Advancements**
**TODAY (circa 2018)**
Baseline

Minimal Plausible Change

Accounts for advances in safety technology, TSMO and mobility services

Baseline

Enhanced Driving Experience

Managed Automated Lanes
AV lane networks

AV travel is consolidated to a large-scale lane network with significant consumer adoption

Ultimate Traveler Assist
Ultra-Connectivity

AV adoption stalls, CV becomes ubiquitous
Driver Becomes Mobility Consumer

- **Niche Service Growth**
  - High AV/CV in certain cases
  - Niche applications for CV/AV dominate the landscape

- **Competing Fleets**
  - Automated TNC fleets compete
  - Level-4 AV is safe for most trips, travel is dominated by competing fleets

- **Integrated Automated Mobility**
  - Automated mobility-as-a-service
  - High automation, strong public-private partnership for system optimization
Key Uncertainties

Connectivity

What percentage of vehicles can both transmit and receive information on the transportation system and on surrounding vehicle movements, and what kind of information are they transmitting?

Automation

What SAE levels of automation are available and affordable, and in what areas can they operate?

Cooperation

To what extent do agencies and companies adjust their operational practices and policies in accordance with other entities? Is there integrated payment, synchronization in schedules, multi-modal infrastructure development, etc.?
<table>
<thead>
<tr>
<th>Scenario Name</th>
<th>Uncertainty Ratings</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Connectivity</td>
<td>Automation</td>
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<tr>
<td>Baseline</td>
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<tr>
<td>Niche Service Growth</td>
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<tr>
<td>Overall System</td>
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<tr>
<td>Niche Service Areas</td>
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<tr>
<td>Ultimate Traveler Assist</td>
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<tr>
<td>Managed Automated Lanes</td>
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<td>Overall System</td>
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<tr>
<td>AV lanes</td>
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<tr>
<td>Competing Fleets</td>
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<tr>
<td>Automated Integrated Mobility</td>
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</tbody>
</table>
Common Assumptions

- Mobile tech & mobility apps advance (multimodal routing, real-time travel info)
- 5G connectivity almost nationwide
- International V2X standards enable interoperability (automakers, construction companies, technology vendors, etc)
- Rigorous cybersecurity testing, industry-standard security systems
Baseline

Trends

- **Current tech improves**
  - Level 2 AV: 30-40% of the market
  - Level 3-4 AV: not commercially available
  - 40% of vehicles V2X capable
  - 5-10% of trips via mobility-on-demand, up to 20% in major cities
  - Pooled rides 0%–40% depending on region

- Real-time travel info near perfect
- Online retail/ same-day delivery grows

Impacts

- Safety improves (urban, affluent regions)
- Urban car ownership declines modestly
- Truck freight costs decrease
- Modest freight shift to truck from rail
- Urban truck/ drone delivery advances
Baseline

Level 2 automated vehicles make up about 30-40% of the market. Level 3 and 4 AVs are not commercially available.

40% of vehicles have V2V/V2I/V2X capability.
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<tr>
<th>Baseline</th>
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</thead>
<tbody>
<tr>
<td>Potential new investments</td>
</tr>
<tr>
<td>• Increased infrastructure maintenance (e.g., lane markings)</td>
</tr>
<tr>
<td>Risks to current investments</td>
</tr>
<tr>
<td>• Some safety investments may no longer be necessary</td>
</tr>
<tr>
<td>Key local issues</td>
</tr>
<tr>
<td>• CV/AV signal improvements, lane marking, signage, charging stations</td>
</tr>
<tr>
<td>• Roadway maintenance</td>
</tr>
<tr>
<td>• Bicycle / pedestrian compatibility</td>
</tr>
<tr>
<td>• TNC/ shared use policy</td>
</tr>
<tr>
<td>• Impact on Complete Streets, Vision Zero, other programs</td>
</tr>
<tr>
<td>• Transit ridership impacts (shared mobility, vehicle ownership, land use)</td>
</tr>
<tr>
<td>• Funding</td>
</tr>
<tr>
<td>• Opportunity costs</td>
</tr>
</tbody>
</table>
Niche Service Growth

Trends

- **Level 4 AV in controlled, contained places**
  - campuses, office parks, retirement communities, downtown districts, first/last mile shuttles, airports

- Technology adoption outside niche areas same as Baseline
  - Level 2 AV: 30-40% of the market
  - 40% of vehicles V2V/ V2I/ V2X capable

Impacts

- Similar to Baseline but niches have better access, safety, and reliability.
- Freight impacts uncertain, not clear if niche services add benefit
- Niches gain competitive edge, attract jobs and residents.
- Niche visitors gain comfort with AV
- Niches are testbeds for new tech
Level 4 automation exists in niche applications, but not in the general system, because of certain barriers: cost, inability to deal with adverse weather and unpredictable/unmapped conditions.

Common niches: college campuses, office parks, airports, first/last mile shuttles, downtown business districts, islands, other cordoned areas.
<table>
<thead>
<tr>
<th>Niche Service Growth</th>
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</thead>
<tbody>
<tr>
<td><strong>Potential new investments</strong></td>
</tr>
<tr>
<td>• New transportation hubs</td>
</tr>
<tr>
<td>• Freight fleet/platooning</td>
</tr>
<tr>
<td><strong>Risks to current investments</strong></td>
</tr>
<tr>
<td>• Reduced gas tax revenues</td>
</tr>
<tr>
<td>• Weight limits for long-span bridges from truck platooning</td>
</tr>
<tr>
<td><strong>Key local issues</strong></td>
</tr>
<tr>
<td>• Curb space management, parking policies, zoning in niche areas</td>
</tr>
<tr>
<td>• Freight facility investments</td>
</tr>
<tr>
<td>• Transit connectivity within/ among/ outside niches</td>
</tr>
<tr>
<td>• Transition zones around niches</td>
</tr>
<tr>
<td>• Management of zero occupant vehicles</td>
</tr>
<tr>
<td>• Enabling pilots and tests, interpreting results in context</td>
</tr>
<tr>
<td>• Mixed traffic (human / machine operated)</td>
</tr>
<tr>
<td>• Interactions with vulnerable road users</td>
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</tbody>
</table>
Ultimate Traveler Assist

Trends

- **CV takes off**
  - 85% of all vehicles have V2X capability (mix of DSRC and 5G)
  - Shared mobility similar to Slow Roll
  - AV similar to Slow Roll
- Ubiquitous, seamless public transit connectivity (in cities that invest) eliminates wait times and first/last mile gaps
- CV driving easier, safer (handling, navigation, finding parking, etc)
- Freight platooning widespread

Impacts

- Congestion nearly eliminated
  - Real-time routing, parking assist, dynamic pricing incentives, truck platooning, etc.
- Massive improvement in safety
  - 80% reduction in crashes
- Increased transit in cities with connected fleets
- Abundant real-time data transforms planning and operations
  - Informs travel demand management, system operations, integrated corridor management
85 percent of all vehicles have V2X capability through a mixture of DSRC and 5G cellular.

AV technology that exists or is in development in 2017 is refined and brought to market at a modest pace.

- Level 2 AVs make up about 30 to 40 percent of the market.
- Level 3 and 4 AVs are not commercially available.

Traveler information is easily accessible and near-perfect in terms of latency and multimodality.
<table>
<thead>
<tr>
<th>Ultimate Traveler Assist</th>
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<tbody>
<tr>
<td><strong>Potential new investments</strong></td>
</tr>
<tr>
<td>- Data collection and management tools, staff capacity</td>
</tr>
<tr>
<td>- Designated infrastructure for CV</td>
</tr>
<tr>
<td>- Subsidized in-car technology/ retrofits</td>
</tr>
<tr>
<td>- New revenue streams from dynamic pricing, other mechanisms</td>
</tr>
<tr>
<td><strong>Risks to current investments</strong></td>
</tr>
<tr>
<td>- Keeping up with ITS infrastructure investments</td>
</tr>
<tr>
<td>- Traffic model assumptions, flexibility re: lane capacity, tripmaking, land use</td>
</tr>
<tr>
<td><strong>Key local issues</strong></td>
</tr>
<tr>
<td>- Zoning, access management policies to control travel flows</td>
</tr>
<tr>
<td>- Seamless, instant public-private data sharing (construction, incidents, travel flows, etc)</td>
</tr>
<tr>
<td>- Coordination with law enforcement</td>
</tr>
<tr>
<td>- Developing common functional class systems</td>
</tr>
<tr>
<td>- Interactions with vulnerable road users</td>
</tr>
<tr>
<td>- Equitable access to opportunity</td>
</tr>
</tbody>
</table>
Managed Automated Lanes

**Trends**

- **AV-only networks on key corridors**
- Vehicles cannot be driven autonomously outside of designated lanes
- 50-60% of vehicles automated
  - Level 2 AV: 30-40% of market
  - Level 3 AV: 20% of the market
  - Level 4 AV: commercially available but rare
- 75% of freight miles automated
- AV lane operators manage speeds
  - Reduces congestion, increases energy efficiency
- Shared mobility, transit use similar to Slow Roll

**Impacts**

- Generally safer, less congested, cleaner
- Value of drive time improves
- Access to central business districts boosts urban economies
  - But downtown parking and congestion rise with influx of drivers.
- Some highway AV lanes extend to arterials
  - Enables suburban growth, more VMT, longer trips
- Intercity freight grows
- Some diversion from rail to truck.
50 to 60 percent of vehicles have some form of automation.

- Level 2 AVs make up 30-40 percent of the market overall.
- Level 3-4 AVs make up 20%, but are rarer since they offer few advantages over lower level AVs in this context of fixed-speed AV lanes.

75 percent of all vehicles, including all AVs, have V2X capability that allows them to communicate immediate safety information to other CVs.

Freight fleets are highly connected and automated with 75 percent of freight highway miles being Level 3 or 4; platooning is nearly ubiquitous.
## Managed Automated Lanes

<table>
<thead>
<tr>
<th>Potential new investments</th>
<th>Risks to current investments</th>
<th>Key local issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data collection and management tools, staff capacity</td>
<td>Ineffective data collection/ management structures</td>
<td>Managing bottlenecks at the extremities of the network</td>
</tr>
<tr>
<td>Downtown parking management</td>
<td>Potential reduced transit demand</td>
<td>First- and last-mile access</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Downtown traffic, parking, curb space management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prioritization, pricing policies for AV corridors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transit’s role in the system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interactions with vulnerable road users</td>
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<tr>
<td></td>
<td></td>
<td>Equitable access to opportunity</td>
</tr>
</tbody>
</table>
Competing Fleets

Trends

- **Litany of different services operates independently and competitively** with no cooperation or centralized management.

- TNCs automate fleets
  - Slash costs, vastly increase market share.
  - Up to 85% of urban/suburban VMT is generated by TNCs operating AV fleets.

- Most vehicles connected and automated at some level
  - AV Levels 2-4: 70% of market
  - V2X capability: 75% of market

- Urban/suburban vehicle ownership drops

- All TNC fleets and most private AVs are electric

- EVs, charging stations proliferate

Impacts

- Urban/suburban VMT, congestion rise
  - Sharp drop in transportation costs
  - New travel by non-driving populations (former transit-dependent + empty VMT)

- Emissions impact uncertain
  - More EVs, but higher VMT.

- Safety improves where AV markets grow

- Accessibility generally improves

- Public transportation is effectively shifted to the private sector
  - Traditional rail and bus riders shift to cheap, flexible TNCs

- AV truck freight grows, costs drop
Competing Fleets

AV technology is approved by safety regulators and is commercially available; 70 percent of vehicles have some form of automation.

- Level 4 AVs are adopted by fleets and make up 30 percent of the vehicle market.
- In urban and suburban areas, up to 85 percent of VMT is completed by CAVs owned by private TNCs.
<table>
<thead>
<tr>
<th>Competing Fleets</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Potential new investments</strong></td>
</tr>
<tr>
<td>- EV charging stations</td>
</tr>
<tr>
<td>- CV infrastructure</td>
</tr>
<tr>
<td>- Subsidy agreements / partnerships</td>
</tr>
<tr>
<td><strong>Risks to current investments</strong></td>
</tr>
<tr>
<td>- Transit operations</td>
</tr>
<tr>
<td>- Roadway wear and tear</td>
</tr>
<tr>
<td><strong>Key local issues</strong></td>
</tr>
<tr>
<td>- Managing access, street space</td>
</tr>
<tr>
<td>- Data management</td>
</tr>
<tr>
<td>- Recharging infrastructure</td>
</tr>
<tr>
<td>- Re-use of parking areas</td>
</tr>
<tr>
<td>- Loss of parking revenue</td>
</tr>
<tr>
<td>- Equity</td>
</tr>
<tr>
<td>- Freight facility investments</td>
</tr>
<tr>
<td>- Interactions with vulnerable road users</td>
</tr>
<tr>
<td>- Local AV regulations</td>
</tr>
<tr>
<td>- Local transit viability</td>
</tr>
</tbody>
</table>
Integrated Automated Mobility

Trends

- Strong public sector leadership fosters system optimization
  - Multimodal travel coordinated through dynamic pricing and other mechanisms
- Like Competing Fleets in other ways:
  - Up to 85% of urban/suburban VMT is generated by TNCs operating AV fleets.
  - AV Levels 2-4: 70% of market
  - V2X capability: 75% of market
  - EVs and charging stations proliferate.

Impacts

- Increased travel, esp. by non-drivers
- VMT and congestion levels vary depending on policy levers such as real-time traffic pricing.
- Public transit rises in cities that leverage integrated automated mobility.
  - In others transit is cannibalized by cheaper TNCs
- Vehicle ownership, emissions, travel time drop
- Safety, accessibility rise
- New freight delivery models eliminate big trucks in some cities.
- Urban parking all but eliminated
- Once-inaccessible neighborhoods attract new residents, businesses
Integrated Automated Mobility

AV technology is approved by safety regulators and is commercially available; 70 percent of vehicles have some form of automation.

- Level 4 AVs are adopted by fleets and make up 30 percent of the vehicle market.
- In urban and suburban areas, up to 85 percent of VMT is completed by CAVs owned by private TNCs.

EV market share sharply increases, particularly in terms of VMT; all TNC rides are electric.

- All heavy-duty freight travel is done with CAVs; freight costs reduce dramatically.
- Concerted effort to coordinate all modes and services, and to synchronize restrictions, pricing, payment, trip booking, travel planning, and the infrastructure and systems to support multi-modal lifestyle.
## Integrated Automated Mobility

### Potential new investments
- EV charging stations
- CV infrastructure
- New transit operational models
- New land uses for areas formerly dedicated to parking

### Risks to current investments
- Public transit if not leveraged

### Key local issues
- Pricing
- Zoning/Curb space management
- Public transit management
- Workforce changes
- Loss of parking revenue
- Potential for affordable housing by unbundling parking
- Equity, vulnerable road users
- Public safety
5. Incorporate Scenario Results into Decision-Making

- Identify local risks and opportunities
- Create an action list and prioritize
- Adjust plans, policies, operational strategies, and investments
Create a list of action items

- Actions (including some that need to wait for more data)
- Changes to policies, operations, investments, regulations, budgeting, etc

Contact relevant staff / agency

- Some actions will involve many parties (internal and external)
- Begins an ongoing dialogue about potential changes

“Do we have sufficient information to act now?”

- Yes
  - Enact change

- No
  - Wait; create & implement research/outreach plan (may include waiting for more data)
Levers: State/ Regional/ Local Policy

- Technology restrictions
  - EV readiness
  - Parking policy
  - Street space/ curb policies
  - Housing codes
  - VMT / travel pricing
  - Occupancy-based incentives
- Infrastructure investments
- Operational strategies
- Public transit investments

Source: Adopting and Adapting State Policies for Automated Vehicles, Eno Center for Transportation www.enotrans.org
6. Monitor industry and policy developments

• Monitor industry and policy developments related to CV and AV, and adjust plans where necessary
Scenario Building Blocks

Forces
- environment… economy…
- society… technology…

Levers
- Investments in infrastructure conditions…
- travel choices… equitable access

Outcomes
- congestion… reliability…
- safety… quality of life…
Technological Forces

- Cybersecurity
- Machine learning
- Rapid sensorization
- EV battery and charging
- Mobile platforms
- Mapping
- New modes (hyperloop, drones, scooters)

- Vehicle design/ decision support tech
- 5G wireless technology/ DSRC adoption
- Big data analytics
- Virtual reality
- Industrial automation/ manufacturing
Consumer Preferences

- Tech acceptance
- Vehicle ownership
- Sharing economy
- Pedestrian activity
- Bike/ scooter preferences

- On demand service trends
- Urban living
- Eco-consciousness
- Working habits
- Trust in government/ regulation
Socio-economic Factors

- Business models (MaaS)
- Aging population
- Nondriving population
- Housing prices
- Employment levels
- Workforce trends

- Market forces (fuel, materials, international leapfrogging)
- Smartphone adoption/ evolution
- Liability/ insurance frameworks
- Urbanization
- Immigration
Levers: National/Global Policy

- Trade policy/tariffs
- International carbon trading
- International regulations on engines or other technology
- Tax incentives and credits
- Technology mandates (such as DSRC on light-duty vehicles)

"Sure, it's a great invention, but does it comply with all government guidelines?"
Outcomes – Place Your Goals Here

- Safety
- Infrastructure Condition
- Congestion Reduction
- System Reliability
- Freight Movement and Economic Vitality
- Environmental Sustainability
- Reduced Project Delivery Delays
- Equitable Access/ Mobility
For More Information …

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